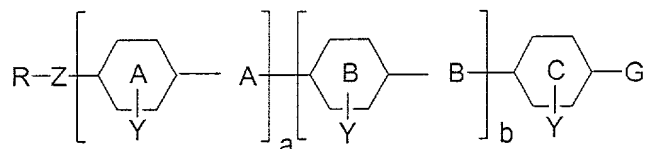


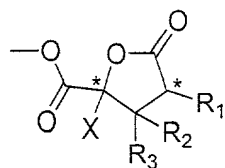
## CLAIMS

We claim:

1. A liquid crystal composition comprising one or more chiral nonracemic compounds of formula:



where the substituents between Z and G represent the core; where G is a chiral nonracemic optionally substituted  $\alpha$ -ester  $\gamma$ -lactone of formula:



where \* indicates a chiral carbon,  $R_1$  is a straight-chain or branched alkyl or alkenyl group wherein one or more non-neighboring carbon atoms can be replaced with an oxygen atom and wherein one or more carbons can be substituted with one or more halogens;

$R_2$  and  $R_3$ , independently of one another, can be H, halogen or a lower alkyl or alkenyl group;

X is H, or a lower alkyl group;

R is selected from the group consisting of:

(1) an achiral straight chain or branched silane or siloxane having one or more silicon atoms and

which may be substituted with one or more halogens

- (2) an achiral linear or branched perfluorinated or partially fluorinated alkyl group ( $R^F$ );
- (3) an achiral linear, cyclic or branched perfluorinated or partially fluorinated ether group;
- (4) an achiral linear or branched ether having one or more oxygen atoms and which may be substituted with one or more halogens;
- (5) an achiral alkyl, alkenyl or alkynyl group which may be substituted with one of more halogens;
- (6) or a straight chain or branched thioether having one or more sulfur atoms and which may be substituted with one or more halogens.

and where:

Z is a linker selected from the group consisting of O, CO, OOC, COO, S or a single bond;

core rings A, B and C can be aromatic or alicyclic; if aromatic, one or two ring carbons can be replaced with a nitrogen; or if alicyclic, rings can contain 3-10 carbon atoms and optionally can contain a double bond, wherein one or two  $CH_2$  of the alicyclic ring can be replaced with a nitrogen, sulfur, or oxygen atom, or a C=O group;

Y represents up to four substituents on a given ring when the ring is aromatic and up to 20 substituents when the ring is alicyclic, where substituents are selected from halides, CN,  $NO_2$ , alkyl or alkoxy;

linkers A and B, independently, are selected from the group consisting of a single bond,  $-COO-$ ,  $-OOC-CH_2-CH_2-$ ,  $-OCH_2-$ ,  $-CH_2-O-$ ,  $-CH=CH-$  (cis or trans);  $-C\equiv C-$ , and  $-CH=CH-CH=CH-$  (cis or trans);

and where a and b are integers that are 0 or 1 and where  $a+b$  is 1 or 2.

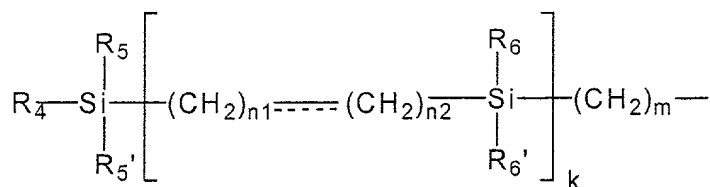
2. The liquid crystal composition of claim 1 wherein the core is selected from the cores in scheme 1.
3. The liquid crystal composition of claim 1 wherein the core rings A, B and C are selected from the group consisting of phenyls, pyridines, pyrimidines and cyclohexanes.
- 5 4. The liquid crystal composition of claim 1 wherein the core is selected from the group consisting of biphenyl; dioxane; optionally substituted phenyl, optionally substituted cyclohexyl, optionally substituted cyclohexenyl, where one or more ring carbons is substituted with O, N or S; phenyl benzoate; phenylpyridine; and phenylpyrimidines.
- 10 5. The liquid crystal composition of claim 2 wherein  $R_1$  is a straight-chain or branched alkyl or alkenyl group wherein one or more non-neighboring carbon atoms can be replaced with an oxygen atom and wherein one or more carbons can be substituted with one or more halogens;
- 15 6. The liquid crystal composition of claim 5 wherein  $R_2$  and  $R_3$ , independently of one another, can be H, halogen or a lower alkyl or alkenyl group;
7. The liquid crystal composition of claim 6 wherein X is H, or a lower alkyl group.
- 20 8. The liquid crystal composition of claim 7 wherein Z is -O- or a single bond.
9. The liquid crystal composition of claim 8 wherein R is an ether, a partially fluorinated ether, or a perfluorinated ether.
- 25 10. The liquid crystal composition of claim 8 wherein R is  $R^F$  and where  $R^F$  is an achiral linear or branched perfluorinated or partially fluorinated alkyl group.

11. The liquid crystal composition of claim 10 wherein  $R^F$  has the formula:  $C_nF_{2n+1}C_mH_{2m}$  wherein n is an integer ranging from 1 to 20 and m is an integer ranging from 1 to 20.

12. The liquid crystal composition of claim 10 wherein  $R^F$  has the formula:  $C_nF_{2n+1}C_mH_{2m}$  wherein n is an integer ranging from 1 to 20 and m is an integer ranging from 0 to 20.

13. The liquid crystal composition of claim 7 wherein R is an achiral alkyl, alkenyl or alkynyl group having from 3 to 20 carbon atoms in which one or more of the non-neighboring carbons can be replaced with an oxygen, or in which one or more of the carbons is substituted with one of more halogens.

14. The liquid crystal composition of claim 8 wherein R is an achiral silane:



where:

$R^4$  is a straight chain or branched alkyl or alkenyl group having one or more carbon atoms and  $R_5$ ,  $R_5'$ ,  $R_6$  and  $R_6'$ , independently of one another, are alkyl groups having from 1-6 carbon atoms;

$n_1$  and  $m$  are integers from 1 to 20;

$n_2$  can be zero or an integer from 1 to 20 where the dashed line indicates a possible double or triple bond;

$k$  is 0 or an integer from 1 to 10;

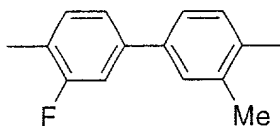
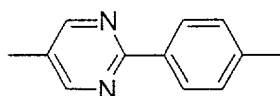
15. The liquid crystal composition of claim 1 wherein R is R<sup>F</sup> and where R<sup>F</sup> is an achiral linear or branched perfluorinated or partially fluorinated alkyl group

16. The liquid crystal composition of claim 15 wherein R<sup>F</sup> has the formula: C<sub>n</sub>F<sub>2n+1</sub>C<sub>m</sub>H<sub>2m</sub> wherein n is an integer ranging from 1 to 10 and m is an integer ranging from 1 to 10.

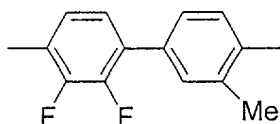
17. The liquid crystal composition of claim 16 wherein R<sup>F</sup> is C<sub>4</sub>F<sub>9</sub>C<sub>4</sub>H<sub>8</sub>.

18. The liquid crystal composition of claim 17 wherein X is O.

19. The liquid crystal composition of claim 18 wherein the core is



OR



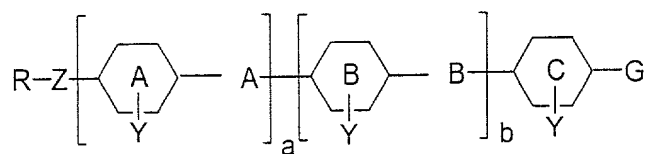
20. The liquid crystal composition of claim 19 wherein R<sub>1</sub> is C<sub>3</sub>H<sub>7</sub>.

21. The liquid crystal composition of claim 20 wherein X is H.

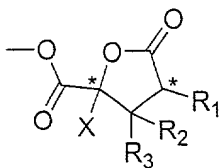
22. The liquid crystal composition of claim 21 wherein X is CH<sub>3</sub>.

23. The liquid crystal composition of claim 1 having a Ps of at least 5 nC/cm<sup>2</sup>.

24. The liquid crystal composition of claim 1 which exhibits a smectic C phase.
25. The liquid crystal composition of claim 1 which can be oriented within an achiral ferroelectric liquid crystal material.
26. A device comprising the liquid crystal composition of claim 1 oriented within an achiral ferroelectric liquid crystal layer exhibiting a smectic C Phase.
27. A liquid crystal compound having the formula:



where the substituents between Z and G represent the core; where G is a chiral nonracemic optionally substituted  $\alpha$ -ester  $\gamma$ -lactone of formula:



where \* indicates a chiral carbon,  $R_1$  is a straight-chain or branched alkyl or alkenyl group wherein one or more non-neighboring carbon atoms can be replaced with an oxygen atom and wherein one or more carbons can be substituted with one or more halogens;

$R_2$  and  $R_3$ , independently of one another, can be H, halogen or a lower alkyl or alkenyl group;

X is H, or a lower alkyl group;

R is selected from the group consisting of:

(1) an achiral straight chain or branched silane or siloxane having one or more silicon atoms and which may be substituted with one or more halogens

(2) an achiral linear or branched perfluorinated or partially fluorinated alkyl group ( $R^F$ );

(3) an achiral linear, cyclic or branched perfluorinated or partially fluorinated ether group;

(4) an achiral linear or branched ether having one or more oxygen atoms and which may be substituted with one or more halogens;

(5) an achiral alkyl, alkenyl or alkynyl group which may be substituted with one or more halogens; and

(6) or a straight chain or branched thioether having one or more sulfur atoms and which may be substituted with one or more halogens.

and where:

Z is a linker selected from the group consisting of O, CO, OOC, COO, S or a single bond;

core rings A, B and C can be aromatic or alicyclic, if aromatic, one or two ring carbons can be replaced with a nitrogen or if alicyclic rings can contain 3-10 carbon atoms and optionally can contain a double bond, wherein one or two  $CH_2$  of the alicyclic ring can be replaced with a nitrogen, sulfur, or oxygen atom, or a C=O group;

Y represents up to four substituents on a given ring when the ring is aromatic and up to 20 substituents when the ring is alicyclic, where substituents are selected from halides, CN,  $NO_2$ , alkyl or alkoxy;

linkers A and B, independently, are selected from the group consisting of a single bond, -COO-, -OOC- $CH_2$ - $CH_2$ -, -O $CH_2$ -, - $CH_2$ -O-, -CH=CH- (cis or trans); -C≡C-, and -CH=CH-CH=CH- (cis or trans);

and where a and b are integers that are 0 or 1 and where a+b is 1 or 2.

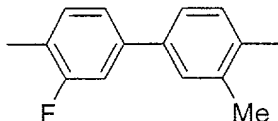
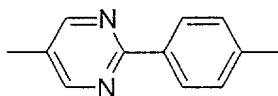
28. The liquid crystal compound of claim 27 wherein R is R<sup>F</sup>.

5 29. The liquid crystal compound of claim 28 wherein R<sup>F</sup> has the formula: C<sub>n</sub>F<sub>2n+1</sub>C<sub>m</sub>H<sub>2m</sub> wherein n is an integer ranging from 1 to 10 and m is an integer ranging from 1 to 10.

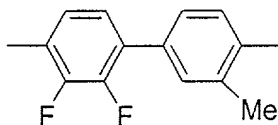
30. The liquid crystal compound of claim 29 wherein R<sup>F</sup> is C<sub>4</sub>F<sub>9</sub>C<sub>4</sub>H<sub>9</sub>.

10 31. The liquid crystal compound of claim 30 wherein X is O.

32. The liquid crystal compound of claim 31 wherein the core is



OR



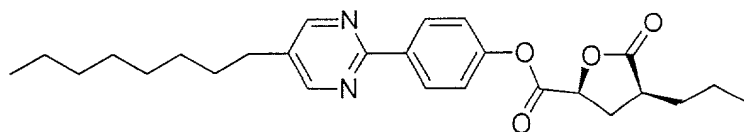
20 33. The liquid crystal compound of claim 32 wherein R<sub>1</sub> is C<sub>3</sub>H<sub>7</sub>.

34. The liquid crystal compound of claim 33 wherein X is H.

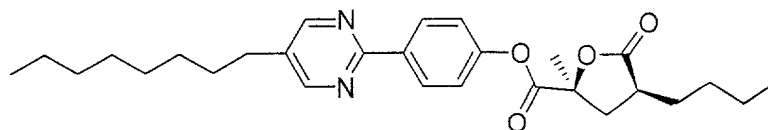
25 35. The liquid crystal compound of claim 34 wherein X is CH<sub>3</sub>.



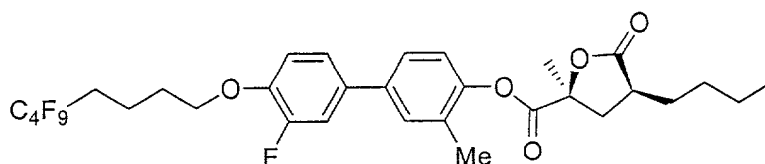
36. A liquid crystal compound having the formula:



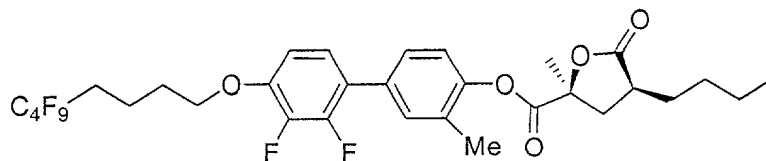
37. A liquid crystal compound having the formula:



38. A liquid crystal compound having the formula:



39. A liquid crystal compound having the formula:



40. A liquid crystal device comprising a composition of one or more of the compounds of claim 27.

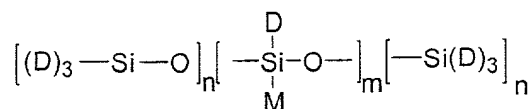
41. A ferroelectric liquid crystal device comprising an achiral smectic C liquid crystal host doped with

from 1 to about 100% by weight of the compound of claim 27.

42. A ferroelectric liquid crystal device comprising an achiral smectic C liquid crystal host doped with from 1 to about 50% by weight of the compound of claim 27.

43. A ferroelectric liquid crystal device comprising an achiral smectic C liquid crystal host doped with from 1 to about 15% by weight of the compound of claim 27.

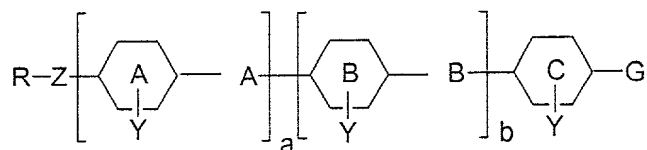
44. A polysiloxane having chiral mesogenic side chains, the polysiloxane having the formula:



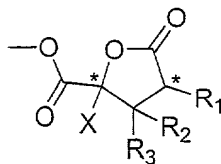
wherein D is an alkyl group having from 1 to 3 carbon atoms; n is either 0 or 1 and when y=0, m

is a number ranging from 10 to 100 and when y=1, m is an integer ranging from 4 to 10 and

wherein M is a chiral nonracemic mesogenic group having the formula:



wherein where G is an optionally substituted  $\alpha$ -ester  $\gamma$ -lactone having the formula:



where  $\text{R}_1$  is a straight-chain or branched alkyl or alkenyl group wherein one or more non-neighboring carbon atoms can be replaced with an oxygen atom and wherein one or more

carbons can be substituted with one or more halogens;

$R_2$  and  $R_3$ , independently of one another, can be H, halogen or a lower alkyl or alkenyl group;

X is H, or a lower alkyl group;

where R is a straight chain alkyl group having from about 6 to about 12 carbon atoms; Z is O or a single bond;

core rings A, B and C can be aromatic or alicyclic; if aromatic one or two ring carbons can be replaced with a heteroatom; or if alicyclic, rings can contain 3-10 carbon atoms and optionally can contain a double bond, wherein one or two  $CH_2$  of the alicyclic ring can be replaced with N, S, O or a C=O group;

Y represents up to four substituents on a given ring when the ring is aromatic and up to 0 substituents when the ring is alicyclic, where substituents are selected from halides, CN,  $NO_2$ , alkyl or alkoxy;

linkers A and B, independently, are selected from the group consisting of a single bond,  $-COO-$ ,  $-OOC-CH_2-CH_2-$ ,  $-OCH_2-$ ,  $-CH_2-O-$ ,  $-CH=CH-$  (cis or trans);  $-C\equiv C-$ ,  $-CH=CH-CH=CH-$  (cis or trans);

and where a and b are integers that are 0 or 1 and where  $a+b$  is 1 or 2.